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APPLICATION FOR UNITED STATES PATENT

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Title: WASTEWATER SOURCE CONTROL SYSTEM

SPECIFICATION

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WASTEWATER SOURCE CONTROL SYSTEM

[0001] This application is a continuation-in-part of Application Serial No. 10/678,009, filed on October 2, 2003, which is hereby expressly incorporated by reference herein.

Field of the Invention

[0002] This invention relates to sewage collection systems including both sanitary sewers and combined sewers.

Background of the Invention

[0003] For purposes of clarification and understanding of this document, the following definitions are set forth. The term "wastewater" designates contaminated domestic wastewater such as "sanitary sewage" as well as water that carries away other waste matters from households, mercantile, commercial, and industrial establishments. "Stormwater" refers to rainfall runoff waters collected in sewers. "Extraneous inflows" refer to waters that enter a sewer collection system by infiltration from ground waters and by inflow from surface water sources especially during stormwater runoff periods. "Combined sewer systems" carry "combined sewage" that is a mixture of wastewater and stormwater plus a certain amount of extraneous inflows. In separate wastewater sewer systems, "wastewater mixtures" are the result of wastewater mixing with extraneous inflows.

[0004] Combined sewer systems are designed to transport combined sewage in the form of wastewater plus a much larger allowance in flow capacity for stormwater and a minor allowance for extraneous inflow. Combined sewage is commonly collected in municipal combined sewer systems; and during low flow periods, combined sewage is mainly comprised of wastewater which is directed via an interceptor pipeline to a wastewater treatment plant. However, when heavy stormwater flows occur, combined sewer flows often exceed the flow capacity of the interceptor; and the overflow is diverted into a receiving

watercourse such as a natural stream or river. These overflows are referred to as combined sewer overflow ("CSO"). However, in high rainfall climates over an annual period, CSOs may be a frequent occurrence resulting in receiving water pollution.

[0005] Separate wastewater sewer systems are designed to transport wastewater plus a limited allowance for extraneous inflow. They do not have direct stormwater connections to surface water inlets as do combined sewers. Although separate wastewater sewer systems are intended to carry mainly domestic wastewater, during high rainfall runoff periods, they also may become overloaded due to extraneous inflows and therefore, carry a wastewater mixture, which is usually a more concentrated form of combined sewage. Overflows from separate wastewater or sanitary sewer systems are generally referred to as a "Sanitary Sewer Overflow" ("SSO"). SSOs generally contain a larger wastewater or sanitary sewage component and are of higher pollution concentrations than CSOs from combined sewers.

[0006] There is a continuing effort to reduce water pollution in watercourses, streams, rivers, lakes, oceans, and other receiving bodies of water from CSO, which is emphasized in the U.S. Environmental Protection Agency (EPA) guidance documents including "Combined Sewer Overflow (CSO) Control Policy (66 FR 42226)" and "Coordinating CSO Long-term Planning with Water Quality Standards Reviews (EPA-833-R-01-002; July 2001)".

[0007] Therefore, there is a need during heavy stormwater runoff periods to prevent, or to some substantial degree avoid, the creation of combined or mixed sewage, thereby reducing CSO and SSO pollution concentrations.

Summary of the Invention

[0008] The present invention is a sewage control system that prevents or reduces the pollution content of combined sewage or wastewater mixtures which often overflow from sewer systems into watercourses, streams, rivers, lakes, oceans, and other receiving bodies of water as a result of heavy rainfall runoff and infiltration.

[0009] According to the principles of the present invention and in accordance with the described embodiments, the invention provides a wastewater source control system for use with a sewer service line conducting a flow of wastewater from a building to a sewer main. A flow control device is installed in the sewer service line; and an actuator is connected to the flow control device. The actuator, in response to an output signal from a hydrologic sensor, causes the flow control device to block the flow of wastewater to the sewer main and detain the flow of wastewater in the sewer service line.

[0010] In one aspect of the invention, the hydrologic sensor is either a flow sensor monitoring a flow in the sewer main or a rainfall sensor. In another embodiment of the invention, in response to the output signal, the wastewater in the sewer service line is detained in a detention tank. In a further embodiment of the invention, the wastewater in the detention tank is pumped therefrom with a sump pump.

[0011] In a further embodiment of the invention, the flow control device is an automatic backflow prevention valve that is used with a detention tank located upstream of the valve. With this embodiment, the hydrologic sensor and associated actuator are not required.

[0012] By detaining building wastewater upstream from its point of discharge into a sewer main during certain heavy stormwater runoff periods, the creation of combined or mixed sewage is prevented or to some substantial degree avoided, thereby reducing CSO and SSO pollution concentrations.

[0013] In a still further embodiment, the invention provides a system of several wastewater source control systems in which each system has a plurality of flow control devices and a plurality of actuators. Each flow control device is installed in association with one of the sewer service lines, and each actuator is in electrical communication with a hydrologic sensor and connected to a respective one of the flow control devices. In response to the hydrologic sensor providing an output signal, each actuator causes a respective one of the flow control devices to block the flow of wastewater from a respective one of the sewer service lines into the sewer main and detain the flow of wastewater in the

respective one of the sewer service lines. In one aspect of this embodiment, the operation of the wastewater source control system is controlled by a computer.

[0014] These and other objects and advantages of the present invention will become more readily apparent during the following detailed description taken in conjunction with the drawings herein.

Brief Description of the Drawings

[0015] Fig. 1 is a schematic illustration of a wastewater source control system in accordance with the principles of the present invention.

[0016] Fig. 2 is a schematic illustration of an alternative embodiment of the wastewater source control system of Fig. 1 utilizing a different hydrologic sensing device.

[0017] Fig. 3 is a schematic illustration of further embodiments of the wastewater source control system of Fig. 1.

[0018] Fig. 4 is a schematic illustration of another embodiment of the wastewater source control system of Fig. 1, which uses a detention tank near a downstream end of a sewer service line.

[0019] Fig. 5 is a schematic illustration of an alternative embodiment of the wastewater source control system of Fig. 4, which uses a detention tank in a building near an upstream end of a sewer service line.

[0020] Fig. 6 is a schematic illustration of another embodiment of the wastewater source control system of Fig. 4, which uses a detention tank and a sump pump inside a building.

[0021] Fig. 7A is a schematic illustration of normal flow of a further embodiment of a wastewater source control system that does not require a hydrologic sensor and associated components in accordance with the principles of the present invention.

[0022] Fig. 7B is a schematic illustration of the wastewater source control system of Fig. 7A under high flow conditions.

[0023] Fig. 8A is a schematic illustration of normal flow of a still further embodiment of a wastewater source control system that does not require a

hydrologic sensor and associated components in accordance with the principles of the present invention.

[0024] Fig. 8B is a schematic illustration of the wastewater source control system of Fig. 8A under high flow conditions.

Detailed Description of the Invention

[0025] Referring to Fig. 1, in one embodiment, drains 15 as well as plumbing fixtures, for example, one or more commodes 16, tubs 17, sinks 18, etc., are connected to one or more soil stacks 19 in a building 20 and discharge wastewater through a building drain piping 22. The building 20 can be used for residential, commercial, or industrial purposes. The building drain piping 22 is connected to an intake or upstream end 23 of a building sewer service line 24, which is located below grade 25 and is often 6 inches (15 centimeters) or more in internal diameter for a single family dwelling. A discharge or downstream end 27 of the sewer service line 24 is connected to a sewer main 34. For purposes of this document, "downstream" refers to a location nearer to, or a direction extending toward, the sewer main 34, and "upstream" refers to a location nearer to, or a direction extending toward, the building 20.

[0026] A wastewater source control system 21 has a flow control device 26 that is connected in the sewer service line for controlling a flow of wastewater in the sewer service line 24. Most often the flow control device 26 is located near the downstream end 27 of the sewer service line 24. The automated flow control device 26 is located in a service box 28 to provide access for maintenance and may be a valve or any device that provides the intended service. The flow control device 26 is operated by an actuator 40 and may be powered by electricity from a battery or other source, air or other fluid pressure, water or other hydraulic pressure, or another source of energy.

[0027] A hydrologic sensing device is used to detect a high flow in a sewer main 34 or an event, for example, rainfall, that would create a high flow in the sewer main 34. In Fig. 1, the hydrologic sensing device may be any device that indicates flow level, flow quantity or depth of flow in a receiving sewer main or

a manhole, for example, a flow level sensor 30, that is located in a manhole 32 and detects a level of flow through a sewer main 34. The sensor 30 provides flow output signals to a signal transmitter 36, which transmits the flow output signals to a signal receiver 38. The transmitter 36 electrically communicates with the receiver 38 using wired or wireless technology. The receiver 38 provides the flow output signals to the actuator 40, which operates the flow control device 26 accordingly. The sensor 30, transmitter 36 and receiver 38 are powered by electricity from a battery or other source.

[0028] In use, during normal periods, the flow control device is open; and wastewater from the building 20 flows through the sewer service line 24, past the flow control device 26 and into the sewer main 34. Without the invention, when the flow through the sewer main 34 includes wastewater from the building 20 plus a heavy stormwater flow, a CSO is often produced in a receiving watercourse. However, with the invention, the flow level sensor 30 detects a greater than normal flow level 42 and provides a high flow signal, which is transmitted to the actuator 40 via the transmitter 36 and receiver 38. The high flow signal causes the actuator 40 to close the flow control device 26, thereby detaining or storing wastewater from the building 20 in the sewer service line 24.

[0029] Wastewater detention volume is approximately 1.5 gallons per ft. or 73 gallons (276 liters) per 50 ft. (15.2 meters) of 6-inch (15-centimeters) diameter building service line. Although building sewer service line lengths and domestic wastewater discharge volumes vary greatly, it is estimated that these volumes will bridge a high percentage of above normal sewer main flows and thus, substantially minimize or prevent CSOs and SSOs.

[0030] As the stormwater flow event lessens, the flow level sensor 30 detects a lesser flow level 44 in the sewer main 34 and provides a lesser flow signal to the actuator 40 via the transmitter 36 and receiver 38. The lesser flow signal causes the actuator 40 to open the flow control device 26, thereby restoring a flow of wastewater from the building 20, through the sewer service line 24 and into the sewer main 34.

[0031] It should be noted that the lesser flow 44 can be equal to or greater than a normal flow 46 through the sewer main 34. Further, if, while the flow control device 26 is closed, should the sewer service line 24 become full as detected by the flow level sensor 30, the actuator 40 causes the flow control device 26 to open, so that wastewater does not backup into the plumbing piping of the building 20. The sensor 30 can be any device that is effective to detect that wastewater has filled the sewer service line 24 upstream of the flow control device 26, for example, a float switch located in the sewer service line upstream of the flow control device 26. Alternatively, instead of using the sensor 30, the flow control actuator can be designed to open in response to wastewater substantially filling the sewer service line 24 upstream of the flow control device 26.

[0032] In a second embodiment of the invention illustrated in Fig. 2, the wastewater source control system 21 uses a rainfall sensor 48 as a hydrologic sensing device in place of the flow level sensor 30 of Fig. 1. The rainfall sensor 48 may be any sensor indicating rainfall intensity or rainfall depth or accumulation. Studies have been done that correlate an amount of rain to CSO and SSO events. Signals representing an amount of rainfall detected by the sensor 48 are provided to the actuator 40 via the transmitter 36 and receiver 38. Upon detecting an amount of rainfall that would provoke a CSO or an SSO, the actuator 40 operates to close the flow control device 26. The period of time that the actuator 40 maintains the flow control device 26 closed is programmed into the actuator 40, and that period of time can be adjusted as the amount of rainfall detected by the rainfall sensor 48 increases. Further, actuator 40 can be set to allow for a lag time corresponding to rising and falling flow in the main sewer 34 so as to avoid a CSO and/or an SSO.

[0033] The wastewater source control system 21 described with respect to a single building of Fig. 1 can also be applied to a plurality of buildings. Referring to Fig. 3, a transmitter 36 is electrically connected to either a sewer main flow sensor 30 or a rainfall sensor 48 and is also in electrical communications over a wired or wireless communications link 50 with a plurality

of receivers 38a-38n. Thus the high flow level signal is provided to a plurality of actuators 40a-40n that are connected to and operate a respective plurality of flow control devices 26a-26n, which are connected in a respective plurality of sewer service lines 24a-24n conducting wastewater from a respective plurality of buildings 20a-20n. Thus, wastewater from a number of buildings 20a-20n that are in a common neighborhood or geographic area can be temporarily detained or stored in respective sewer service lines 24a-24n during an event, for example, a thunderstorm, that would normally lead to a CSO or an SSO.

[0034] In a further embodiment, control of the wastewater retention can be centralized. A wastewater management facility 52 has a receiver 54 connected to the communications link 50, which receives the signals from the transmitter 36. In this embodiment, the receivers 38a-38n are not receptive to signals from the transmitter 36. Further, there are a number of other wastewater source control systems 60, 62 that are similar to the wastewater source control system 58. The wastewater management facility 52 receives signals from a plurality of hydrologic sensing devices 30, 48 that are located in the various wastewater source control systems 58, 60, 62. By monitoring signals from the various hydrologic sensing devices 30, 48, personnel in the wastewater management facility 52 provide further signals via a transmitter 56 to the receivers 38a-38n for operating the flow control devices 26a-26n in the various wastewater source control systems 58-62. Alternatively, a computer system 53 within the wastewater management facility 52 can provide signals controlling the operation of the flow control devices 26a-26n in the wastewater source control systems 58-62 in response to signals from the hydrologic sensing devices 38, 48.

[0035] Referring to Fig. 4, in situations where the sewer service line 24 is relatively short or where more detention storage is needed, the wastewater source control system 21 provides a detention tank 64 that is installed in the sewer service line 24 to increase storage capacity. The detention tank 64 can be formed by using a tank component or enlarging a section of the sewer service line 24. Where more than one source is served, the detention tank 64 should

be enlarged and designed as needed. This may be applied for example in the case where the building 20 is a multi-family facility. The operation of the wastewater source control system 21 of Fig. 4 is substantially similar to that previously described with respect to Figs. 1-3. Under normal conditions, wastewater flows freely through the sewer service line 24 and the detention tank 64, past the flow control device 26 and into the sewer main 34. Under high flow conditions detected by the hydrologic device, the flow control device 26 is closed; and wastewater is detained in the detention tank 64. Upon detecting lower flow conditions, the flow control device 26 is opened and normal wastewater flow is resumed. As before, the hydrologic sensing device may be implemented using a flow sensor 30 or a rainfall sensor 48.

[0036] Referring to Fig. 5, the detention tank 64 of the wastewater source control system 21 may be provided in a basement or lower level containment box in the building 20 if the sewer service line 24 is short or for other reasons. During normal flow 46 in the sewer main 34, the building wastewater discharges from its plumbing fixtures and flows through the building drain piping 22, into the detention tank 64, through the tank outlet 76, through a cleanout 78 and out the sewer service line 24 to the sewer main 34. As previously described, in operation, the receiver 38 detects a high flow signal from the transmitter 36 representing a higher flow 42 in the sewer main 34 detected by the flow sensor 30. That high flow signal causes the flow control device 26 to close and detain wastewater in the detention tank 64. Typically, a round cross-sectional shape of light weight, non-corrosive materials will be most efficient for passage of flows. The detention tank 64 is provided with an air vent pipe connection 72 and an overflow outlet 74 to bypass flow to the sewer service line 24 when the tank becomes full. A tank outlet pipe 76 is connected to a running trap and clean-out fitting 78 and then to the sewer service line 24 that connects to the sewer main 34. In an alternative embodiment, the detention tank 64 may also be located outside the building 20 in an appropriate structure and may have a connection to one or more wastewater sources.

[0037] Referring to Fig. 6, in those applications where gravity flow is inadequate, that is, the building drain pipe 22 is lower than the upstream end of the sewer service line 24, the waste water control system 21 includes a sewage pump 66. In this embodiment, the detention tank 64 and sewage pump 66 are installed in an interior, lower portion, of the building 20. In operation, the combination of the detention tank 64 and sewage pump 66 function as a flow control device to regulate the flow of wastewater from the building 20 during normal and excessive flow conditions in the sewer main 34. Under normal flow conditions in the sewer main 34, wastewater flows into the detention tank 64. A first liquid level sensor 70, for example, a float connected to a movable contact of a limit switch, detects a first, lower level of liquid in the detention tank 64 and provides a signal to the sewage pump 66. The sewage pump 66 operates in a known manner to pump wastewater out of the detention tank 64, up through a discharge pipe 68, through a cleanout 78 and into the sewer service line 24. Therefore, during normal sewer main flow conditions, there is a substantial wastewater reserve capacity in the detention tank 64. An air ventilation pipe 82 is provided from the detention tank 64 for ventilation of any gases.

[0038] If an event occurs that leads to a high flow in the sewer main 34, the receiver 38 detects a high flow signal from the transmitter 36 representing a higher flow 42 detected by a hydrologic sensing device, for example, the flow sensor 30 or rainfall sensor 48. That high flow signal from the receiver 38, via a relay or other means, interrupts the connection of output signal from sensor 70 to the sewage pump 66. Therefore, the sensor 70 does not operate the sewage pump 66, and wastewater is able to accumulate in the detention tank 64 to levels above the sensor 70. Building wastewater is detained in the tank 64 until the flow in the sewer main 34 again subsides to a lower level 44. A low flow signal is then provided by the flow level sensor 30, which is transmitted to the receiver 38 via the transmitter 36. The receiver 38 provides the low flow signal to the sewage pump 66, thereby causing the output signal from the sensor 70 to be reconnected to the sewage pump 66. The sewage pump 66 then operates to pump wastewater from the detention tank 64 until it is below a level detectable

by the sensor 70, and thereafter, the sewage pump 66 operates under low flow conditions as first described. A liquid level sensor 71 may be used to detect when the detention tank 64 is full and provide an output signal to operate the sewage pump 66, thereby providing overflow relief.

[0039] While the embodiment of Fig. 6, demonstrates the use of the invention in those applications where the building drain piping 22 is below the sewer service line 24, the invention illustrated and described therein can be used where the building drain piping 22 is above the sewer service line 24. In those applications, the tank 64 is used as a wastewater storage tank during periods of high flow in the sewer main 34.

[0040] In still further embodiments of the wastewater source control system, the complexities and costs of the hydrologic sensor and associated transmitter, receiver and actuator can be eliminated. In the embodiment of Fig. 7A, the wastewater source control system 21 uses a flow control device 26 that is an automatic backflow prevention valve. Such in-line automatic backwater valves for sewer service lines are commercially available, for example from the Jay R. Smith Manufacturing Co. of Montgomery, Alabama.

[0041] During normal flow periods, the flow control device 26 is open; and wastewater from the building 20 flows through the sewer service line 24, past the flow control device 26 and into the sewer main 34. Without the flow control device 26, when the flow through the sewer main 34 includes wastewater from the building 20 plus a heavy stormwater flow, a CSO is often produced in a receiving watercourse. As shown in Fig. 7B, a heavy stormwater flow may result in a surcharge condition, which is defined by a hydraulic gradient above the crown of the sewer. In such event, stormwater flow begins to backflow through the downstream end 27 of the sewer service line 24. Without the flow control device 26, during a surcharge condition, stormwater can backflow through the sewer service line 24 and through the drain 15 in the building 20. However, the flow control device 26 in the form of an automatic backflow prevention valve 26 responds to the presence of the backflow in the sewer service line and automatically closes. The closed flow control device 26 prevents any further

backflow of stormwater through the sewer service line 24, and the backflow of stormwater through the drain 15 in the building 20 is prevented.

[0042] As will be appreciated, the closed flow control device 26 also prevents wastewater from the building 20 from flowing into the lower end 27 of the sewer service line 24 and into the sewer main 34. Further, while the flow control device 26 is closed, building wastewater can also backup in the upstream portion 23 of the sewer service line 24 and backflow through the drain 15 in the building 20. Anticipating that event, many automatic backflow prevention valves are sold with warning systems that alert occupants of the building 20 of a flow control device closure, during which time the building occupants should cease using plumbing fixtures. When the storm event is over and normal flow returns to the sewer main 34, as the stormwater recedes from the downstream portion 27 of the sewer service line 24, the flow control device 26 automatically opens.

[0043] Prohibiting the use of plumbing appliances during the time that the flow control device 26 is closed is a substantial inconvenience to the occupants of the building 20. Further, it is highly probable that some occupants will ignore, or not be aware of, the valve closing warning. To eliminate that inconvenience, the present invention utilizes a detention tank 64 that may be implemented using any device to provide the desired wastewater storage, for example, an oversized piece of sewer service line, etc. Thus, while the flow control device 26 is closed, building wastewater is detained in the detention tank 64. After the surcharge condition has passed, the flow control device 26 responds to stormwater flowing out of the lower end 27 of the sewer service line 24 and automatically opens; and building wastewater again flows freely through the sewer service line 24 and into the sewer main 34. The detention tank 64 then drains, and a normal flow condition as illustrated in Fig. 7A is restored.

[0044] In an alternative embodiment of the wastewater source control system 21 shown in Fig. 8A, the flow control device 26 is again an automatic backflow prevention valve as previously described. However, in the embodiment of Fig. 8A, the flow control device 26 and the detention tank 64 are located in a basement or lower level containment box in the building 20. During normal flow

46 in the sewer main 34, the building wastewater discharges from its plumbing fixtures and flows through the building drain piping 22, into the detention tank 64, through the tank outlet 76, through a cleanout 78 and out the sewer service line 24 to the sewer main 34. As previously described, as shown in Fig. 8B, a heavy stormwater flow may result in a surcharge condition; and in such event, stormwater backflows through the sewer service line 24. The flow control device 26 responds to the presence of the backflow in the sewer service line and automatically closes. The closed flow control device 26 prevents backflow of stormwater through the drain piping 22, the drain 15 and into the building 20. While the flow control device 26 is closed, building wastewater is detained in the detention tank 64. After the surcharge condition has passed, the flow control device 26 responds to stormwater flowing out of the sewer service line 24 and automatically opens; and building wastewater again flows freely through the sewer service line 24 and into the sewer main 34. The detention tank 64 then drains, and a normal flow condition as illustrated in Fig. 8A is restored. As shown in Fig. 8B, a liquid level sensor 84 may be used to detect when the detention tank is full or close to full. In that event, the liquid level sensor provides an output signal to a warning device 86 that provides an audible, visual or other sensory perceptible warning indicating that the detention tank is full. The occupants of the building are thus warned not to continue to use the plumbing devices in the building.

[0045] In the embodiments of Figs. 4-8, the detention tank 64 and sewage pump 66, if used, are sized according to hydrologic conditions needed to detain the discharge of building wastewater during higher than normal stormwater flows 42 in the sewer main 34. The volume of the detention tank 64 is based on the storage of building wastewater discharges needed to bridge typical wet weather flow periods in the sewer main 34. This requires a hydrologic analysis based on statistical rainfall data periods of the region in combination with typical wastewater discharge from domestic dwellings or building sources. For example, a 10 feet (3.05 meters) length of 12 inch (30.5 centimeters) diameter sewage service line has a detention volume of approximately 58 gallons (220

liters). Depending on the hydrologic region, this volume is in a range sufficient to detain single family domestic sewage during most typical periods of a CSO. The detention tank 64 may be of any shape, dimensions, or volume which provide for efficient fluid flow and the intended service, however a round pipe or tank of lightweight flexible material, such as a high strength plastic, may be cost effective. In an alternative embodiment, the detention tank 64 may also be located outside the building 20 in an appropriate structure and may have a connection to one or more wastewater sources. Further, as will be appreciated, the embodiments of Figs. 4-8 may also be implemented in larger system schemes as illustrated and described with respect to Fig. 3.

[0046] All of the embodiments of the wastewater source control systems of Figs. 1-8 will work with any sewer main of any size constructed on hydraulically mild, open channel, flow bottom slopes, that is, sub-critical or tranquil flow, or on hydraulically steep, open channel, flow bottom slopes, that is, super-critical or rapid flow. However, the wastewater source control systems are expected to be more sensitive for mild slope applications with prevailing sub-critical or tranquil flow. Further, the wastewater source control systems of Figs. 1-6 will work for typical domestic wastewater discharges, however, for certain non-domestic building discharges, such as commercial or industrial wastes containing high concentrations of solids, a maceration device or a grinder pump is recommended for maintaining fluid flow. It should be noted that in all of the embodiments shown and described with respect to Figs. 1-8, the flow control device 26 not only detains upstream wastewater from the building 20; but the flow control device 26 also prevents wastewater from backing up from the sewer main 34 into the building 20.

[0047] By using the various embodiments of the invention shown and described with respect to Figs. 1-8, building wastewater is detained upstream from its point of discharge into sewer mains during heavy stormwater runoff periods. Thus, one advantage of the invention is that the creation of combined or mixed sewage is, in some applications, to some substantial degree avoided and, in other applications, prevented. Another advantage of the invention is the

reduction of pollution content of combined sewage or wastewater mixtures that overflow from sewer systems into watercourses, streams, rivers, lakes, oceans, and other receiving bodies of water as a result of heavy rainfall runoff and infiltration. A further advantage of the invention is that it prevents wastewater from backing up from the sewer main 34 into the building 20.

[0048] While the present invention has been illustrated by a description of an embodiment, and while such embodiment has been described in considerable detail, there is no intention to restrict, or in any way limit, the scope of the appended claims to such detail. Additional advantages and modifications will readily appear to those skilled in the art. For example, the described embodiment relates to a combined sewer system in which wastewater from the building 20 and stormwater are combined in the sewer main 34. As will be appreciated, in a separate wastewater system in which there is one sewer main for wastewater and a second, separate sewer main for stormwater, overflows can still occur in the wastewater sewer main. In those applications, the various embodiments of the invention described with respect to Figs. 1-8 can be applied to the separate wastewater system in the same manner as described herein in order to eliminate or substantially reduce the occurrence of overflows in the wastewater sewer main.

[0049] In the embodiments described herein, the flow control devices 26 are operated by respective actuators 40; however as will be appreciated, in alternative embodiments, the flow control devices 26 can be operated manually to provide the desired detention of wastewater prior to it entering a sewer main. Such manual operation can be initiated by one or more signals generated by a flow sensor or a rainfall sensor or, in response to instructions provided from a central wastewater management facility by broadcast or otherwise.

[0050] In the embodiment of Figs. 5, 6 and 8 the detention tank 64 and sewage pump 66, if used, are located inside the building 20; however, as will be appreciated, in an alternative embodiment, the detention tank 64 and sewage pump 66, if used, can be installed in a service box 28 located outside the building 20.

[0051] In the embodiments shown in Figs. 4 and 7, the detention tank 64 is shown at the downstream end of the upper portion 23 of the sewer service line 24. As will be appreciated in alternative embodiments, the detention tank 64 may be located at the upstream end of the upper portion 23 of the sewer service line 24. Further, the detention tank 64 can be located either inside or outside a perimeter of the building 20. In the embodiments of Figs. 7 and 8, the flow control device 26 can also be implemented with a pinch valve, for example, a Type A, model 4700 pinch valve commercially available from Red Valve Company of Carnegie, Pennsylvania.

[0052] Therefore, the invention in its broadest aspects is not limited to the specific details shown and described. Consequently, departures may be made from the details described herein without departing from the spirit and scope of the claims which follow.

[0053] What is claimed is: